An Overview of Smart Grid Issues

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Discussion Outline - Overview

What is Smart Grid ?

A. Define Smart Grid
   a) Enable consumers
   b) Automation
   c) Alternatives – Renewables

B. Establish a vision
   a) Who is the customer
   b) Problems to resolve
   c) Costs and Benefits
   d) Where do you start

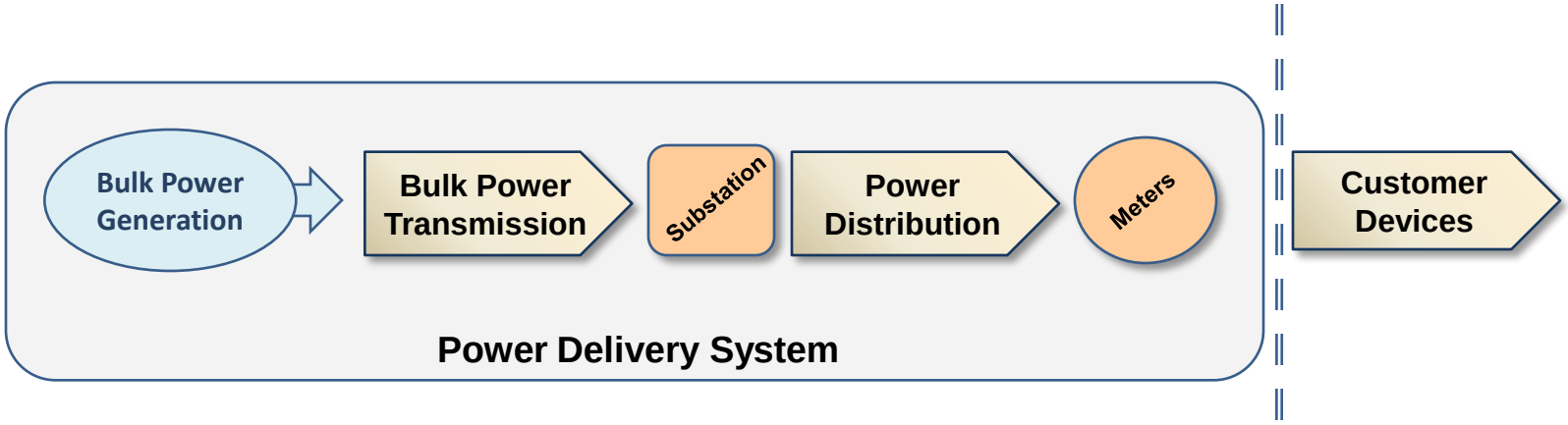
A. Define Smart Grid

Smart Grid is System Integration

The Smart Grid is a system of information and communication applications integrated with electric generation, transmission, distribution, and end use technologies which will :

Promote Customer Choice	[1] **enable consumers** to manage their usage and chose the most **economically** efficient offering, while
Improve Reliability	[2] use **automation** and alternative resources to maintain delivery system **reliability and stability**
Integrate Renewables	[3] utilize the most **environmentally gentle** renewable, storage, and generation **alternatives**.

A. Define Smart Grid



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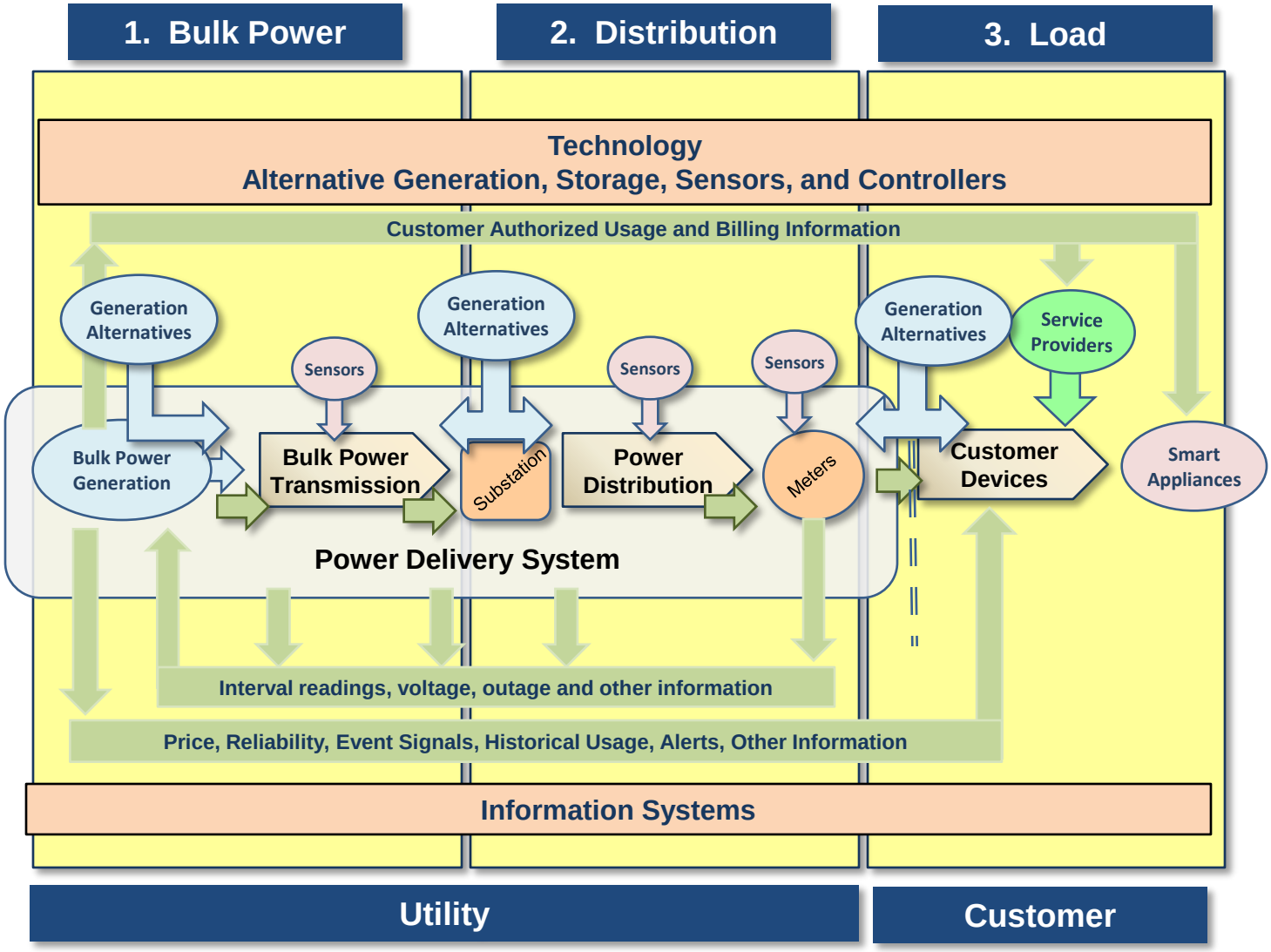
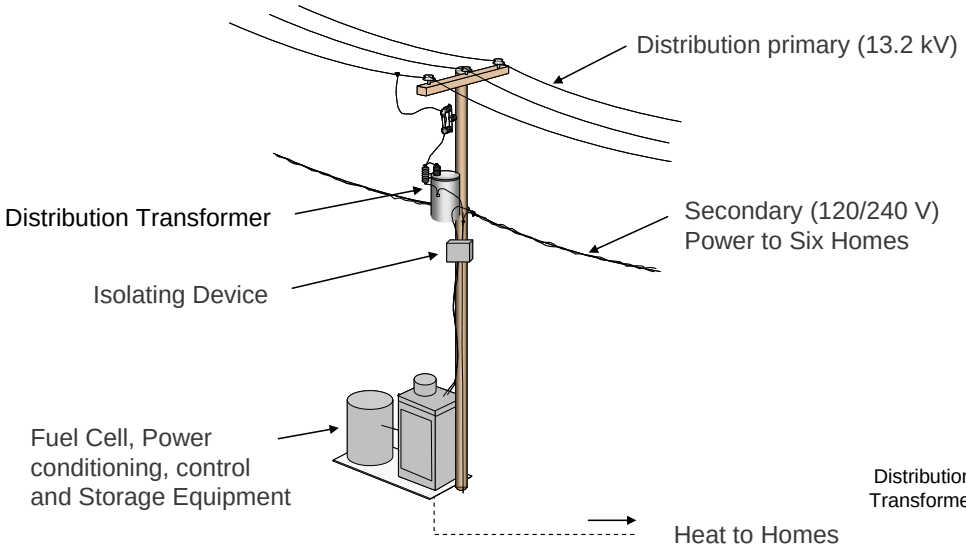
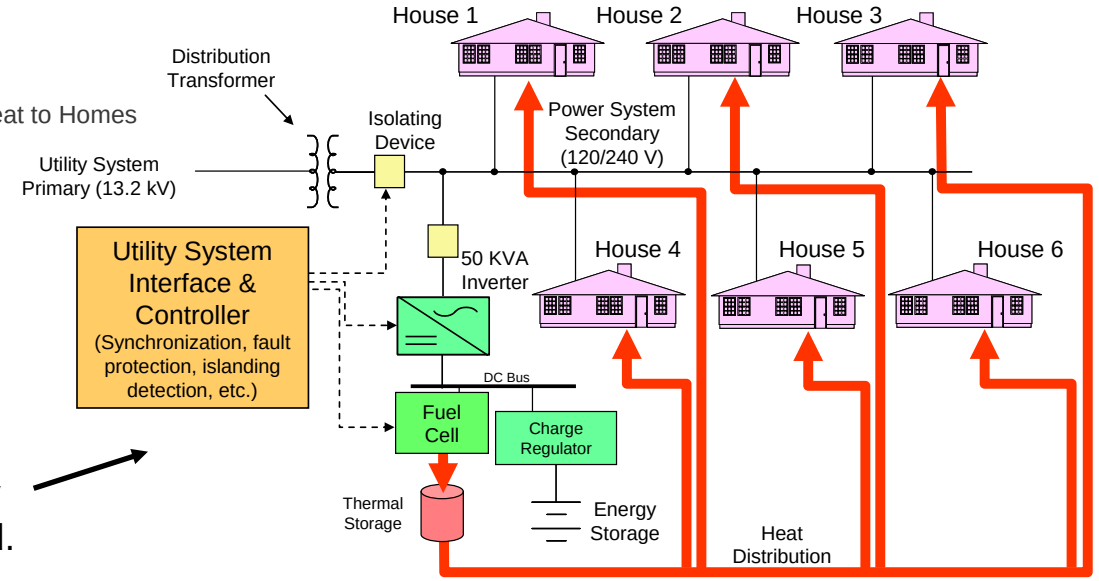


A. Define Smart Grid – Residential Micro Grid



An efficient and reliable micro-grid doesn't need to be large or overly complex.



This could be several homes or several hundred homes – the generation & storage would simply be scaled to accommodate the load.

A. Define Smart Grid

	Claimed Societal Benefits	Attribute	Realistic ?
1	Dramatic reduction in tailpipe emissions	1-6	
2	Reduction in petroleum imports of >50%	1-5	
3	Reduction in peak loads – lowering prices for consumers	2, 3, 5	
4	Improved grid reliability	4-6	
5	Increased grid security	4-6	
6	Positive environmental impact	1-7	
7	Enable new products, services and competitive retail markets	3	
8	Anticipate and respond to system disturbances (self-heal)	4-6	
9	Perform continuous self-assessment, respond faster by supplementing human operators.	4-6	
10	Operate resiliently against attack and be less vulnerable to natural disaster	4-6	

1. PHEV's 2. Advanced Metering 3. Dynamic Rates 4. Sensing
5. Automation 6. Expert Systems 7. New Technology

Sources: Industry presentations and publications, see Slide #9.

A. Define Smart Grid

	Claimed Consumer Benefits	Attribute	Realistic ?
1	Equivalent of $1.00 per gallon for gasoline	1	
2	Provide prices and opportunity to buy when KWh prices are low and sell when high	2-7	
3	Home back-up power and mobile resource	1, 2-7	
4	Protecting against power losses and avoiding costly interruptions and spoilage	2-7	
5	Reducing the cost of electricity during peak power periods,	2-3	
6	Customer choice from products to services	2, 3	
7	Enhanced system reliability	2, 3	
8	Enable active participation by consumers	2, 3, 5, 7	
9	power quality at different prices	2, 3, 5	
10	Consumers access to information, control and options that allow them to better manage energy and environmental costs	2, 3, 5, 7	

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A. Define Smart Grid

	Claimed Utility System Benefits	Attribute	Realistic ?
1	Minimizing energy transmission losses	7	
2	Improving the efficiency of the electricity grid.	2-7	
3	Increased efficiency of power delivery	2-7	
4	Extended asset life	?	
5	Seamlessly integrate generation and storage options	[2,3,5] [4-7]	
6	Operate efficiently to improve load factors, lower system losses, and improve maintenance.	[2,3,5] [4-7]	
7	Grid operators have new resource options to provide energy, capacity and ancillary services	[2,3,5] [4-7]	

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Sources
1. The Smart Grid – Benefits and Challenges, EEI Annual Convention, J.Miller – Modern Grid Strategy Team, June 16, 2008
2. What will the Smart Grid Look Like ?, A Vision for the Smart Grid., DOE Office of Electricity Delivery and Energy Reliability, June 2008.
3. Miscellaneous public reports, press releases, presentations, and private sources.

B. Vision of smart grid ?

1. Which customer(s) are you trying to serve: end-user (rate payer) or the utility ?
2. What problem(s) are you trying to solve: manage future costs, improve reliability, or integrate renewables ?
3. How is the "Smart Grid" different from what you've already been doing ?
4. What are the smart grid costs and benefits?
5. Where do you start and what information do you need to proceed: [1] Pilot programs or [2] Transition Plan ?

Discussion Outline – Key Issues

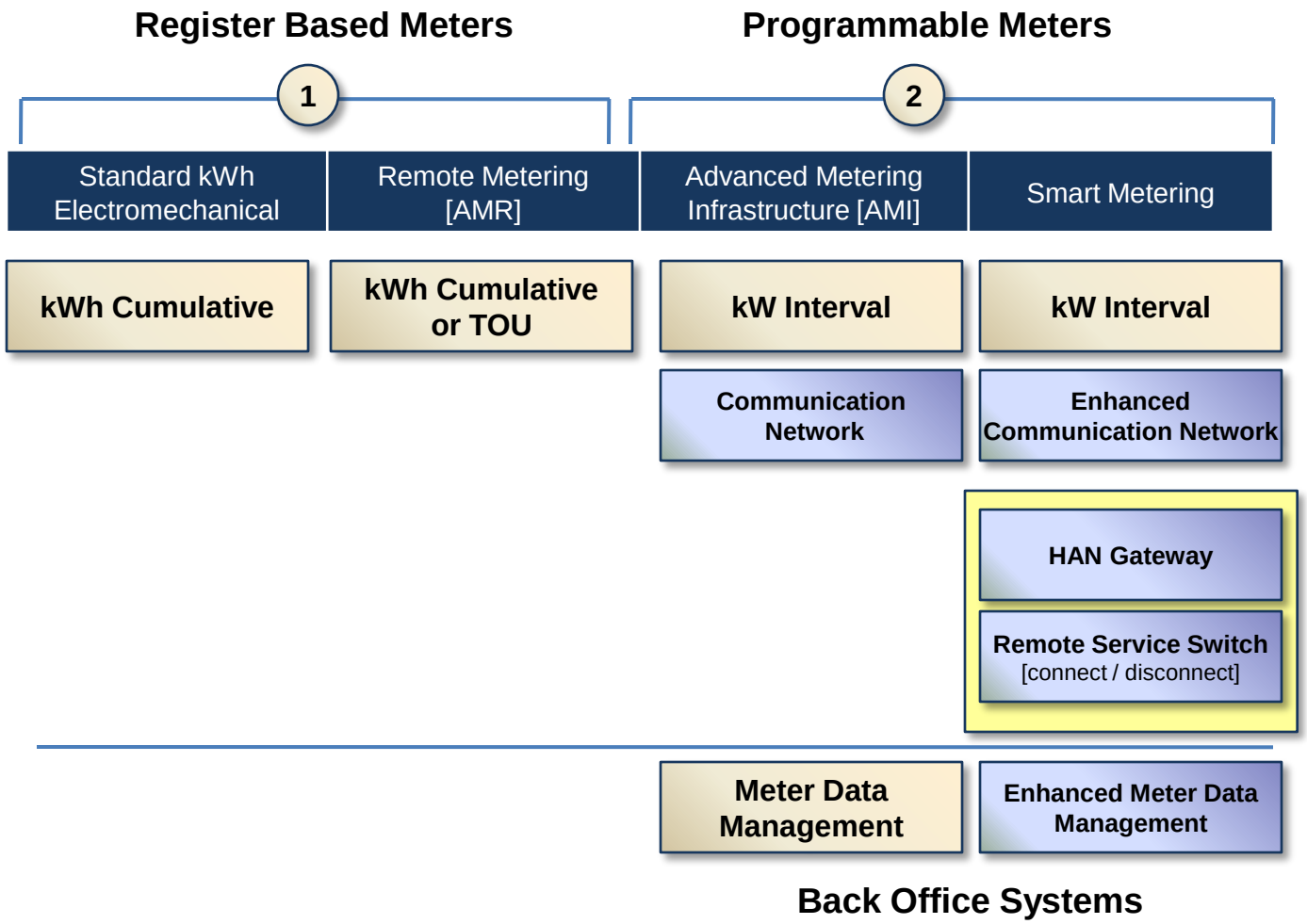
Key Smart Grid Regulatory Issues ?

1. Metering
2. Rates
    a) Rate Design
    b) Demand Response
    c) Empowering the Customer
3. Reliability
4. Pilots or Transition Plans
5. Standards

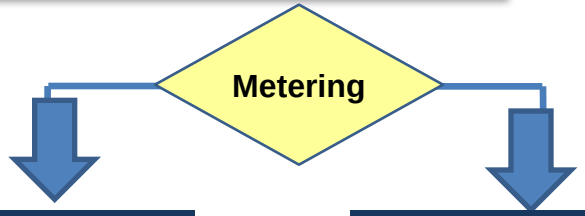
Key Issues ?

1. System integration vs. hardware integration
   a) Advanced meters vs. Smart meters ?
   b) What is the role of the HAN?
2. Establishing a business case [costs and benefits]
3. Targeted vs. system-wide implementation
4. Security and privacy – who owns the data ?
5. Utility vs. the regulatory / customer use case
   a) utility programs or open markets
   b) Customer vs. utility control strategies
6. Standards – Communication and hardware vs. data models.

1. Metering: Two Fundamental Choices



1. Metering: Two Fundamental Choices



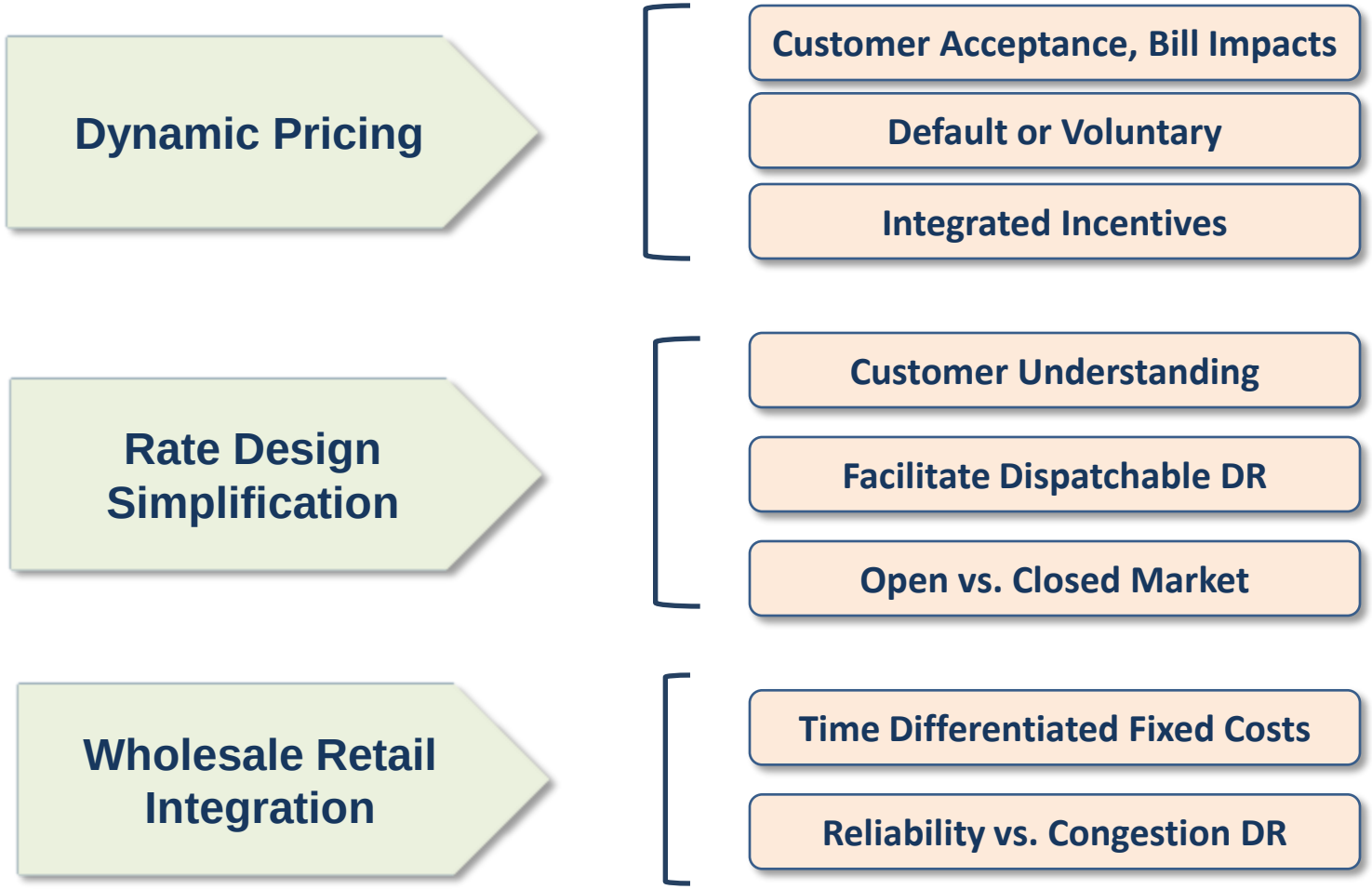
Metering System	Advanced	Smart	Tradeoffs - Issues
Primary Function	Interval Recording	Interval Recording	none
Communications Capability	Network, two-way	Network, two-way into customer premise	•Focus on Meter Network •Reach into customer premise
Remotely Configurable Demand Limit Connect-Disconnect Service Switch	A separate piece of equipment	Integrated	Hardware Integration
Home Area Network Gateway	Separate system or piece of equipment	Partially Integrated	Partial Hardware Integration
Cost Range per Meter [excludes customer devices]	**$70-$150**	**$130-$250**	**Cost, Depreciation, Obsolescence**
Data Collection	Interval kWh	•Interval kWh •Customer device status	•More complex data • Security and Privacy
Rate Forms Supported	Flat, Tiered, TOU, Dynamic	Flat, Tiered, TOU, Dynamic	none
Support for Usage Displays	Remote Access Separate Service	Integrated Plus Separate Service	Thru the Meter
Obsolescence Ranking	Low to Moderate	Moderate to Uncertain	Increased Risk
Support for Market Based Devices and Services	Open	"Gate Keeper" Potential	May Limit Open Market

2. Rates and Pricing

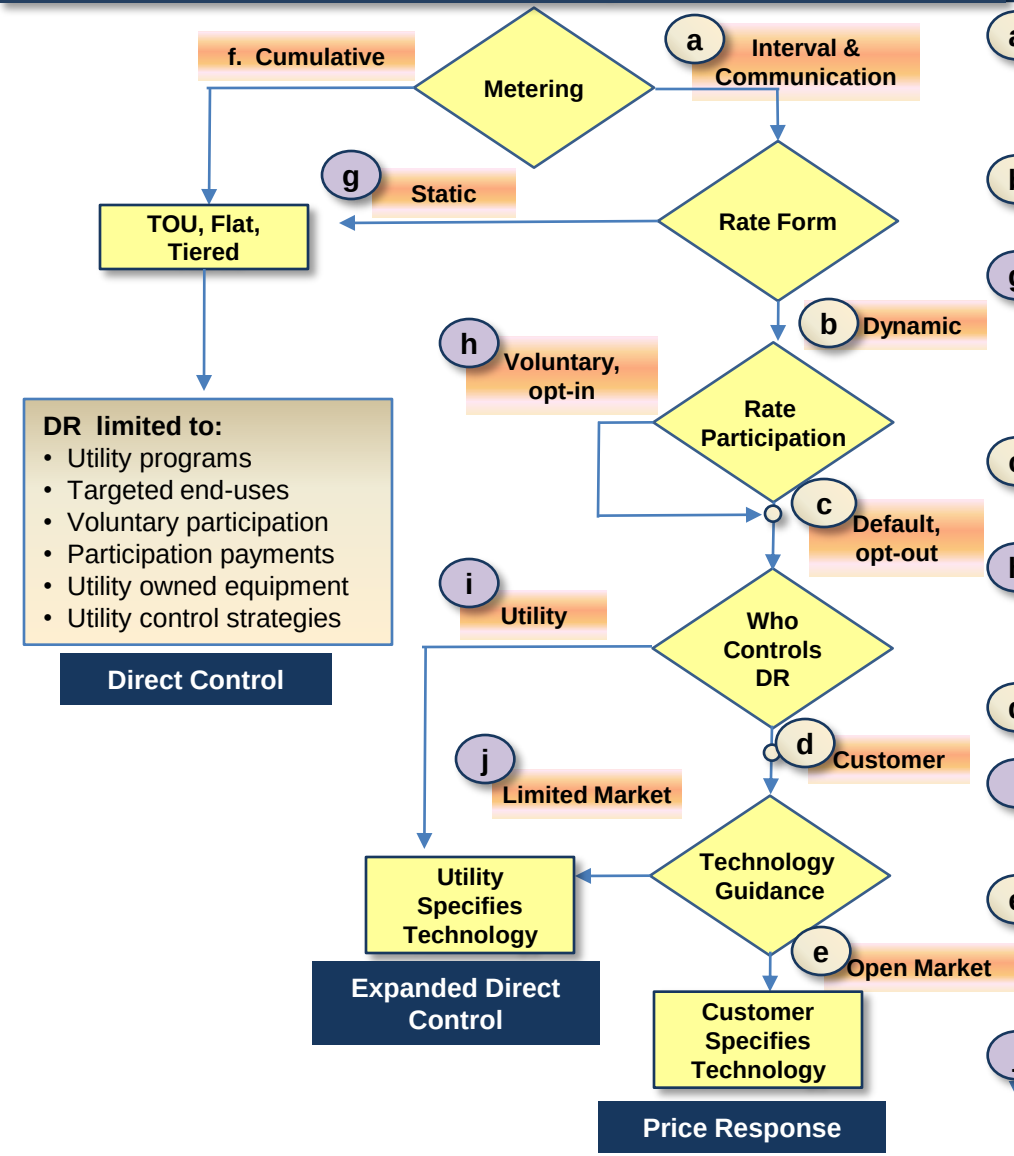
- **Rate designs and pricing are the integrating link between the physical utility transmission-distribution system and customer**

- **Rate designs influence the efficiency, demand response, and renewable potential .**

2. Rates [Pricing] - Issues



2. Rates and Pricing - Tradeoffs



a
- Interval metering provides data to support all rate forms.
- Communication supports dynamic rate, outage management, and customer information options.

b
- Dynamic rates (CPP, RTP) reflect system costs and support dispatchable economic and reliability options.

g
- Static rates do not reflect system costs or performance based rates / incentives.

c
- Default, opt-out rates create a market for DR.
- EE and DR implicit conditions of service for all customers
- DR ubiquitous system wide
- Expands and creates a market for customer ownership and competitive equipment providers.

h
- Voluntary, opt-in rates restrict the creation of open markets for DR and can significantly increase transaction costs for utility or ISO/RT programs.
- Limits ubiquity and value of DR.

d
- Customer choice opens the market for competitive non-utility DR suppliers and service providers

i
- Direct control disincents customer ownership and restricts competitive equipment and service providers

e
- Customer value establishes technology options
- Regulators establish: (1) Need for subsidies to address market barriers, (2) Data models - to provide interoperability, and (3) Data ownership to address security and privacy

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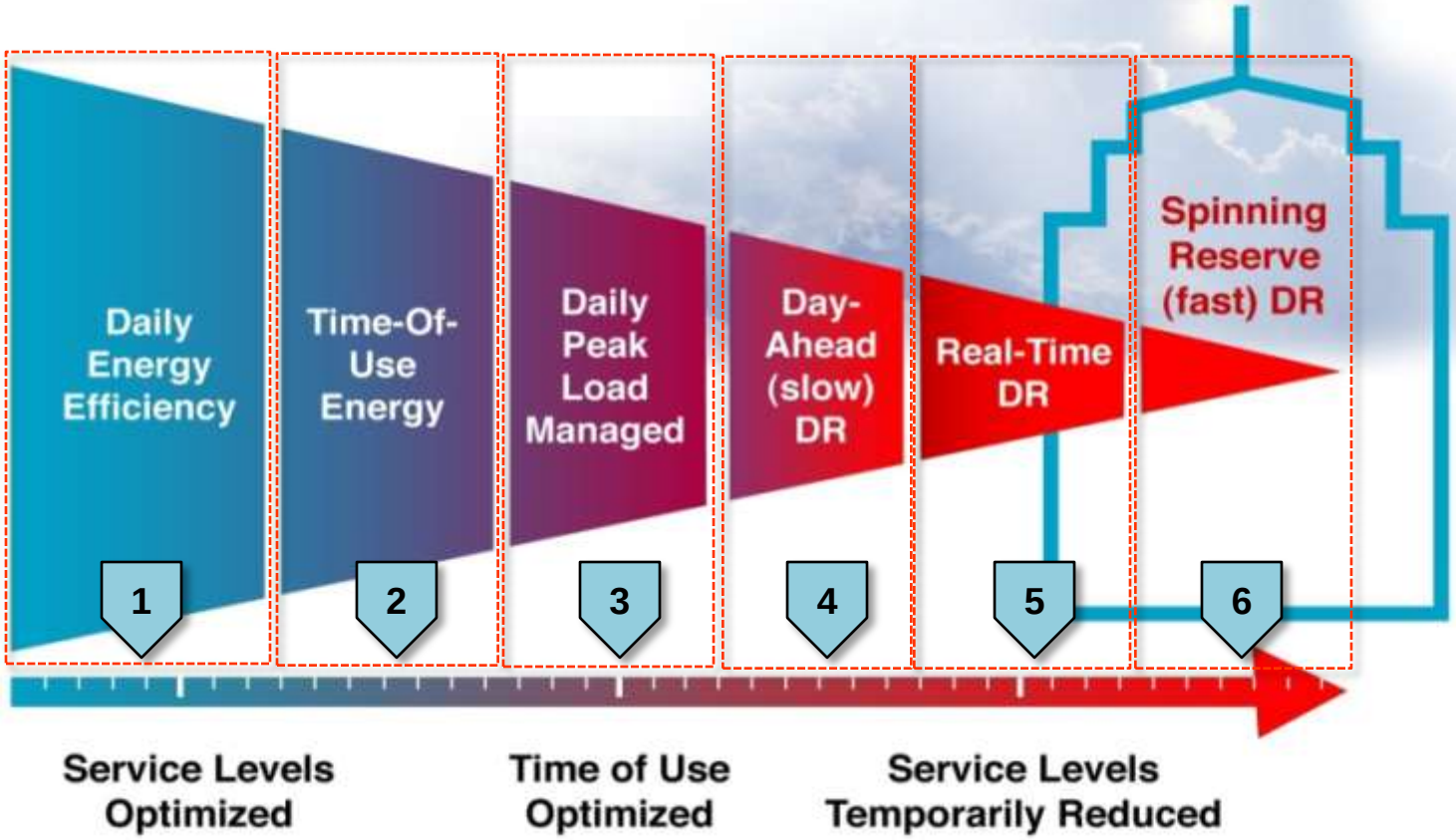
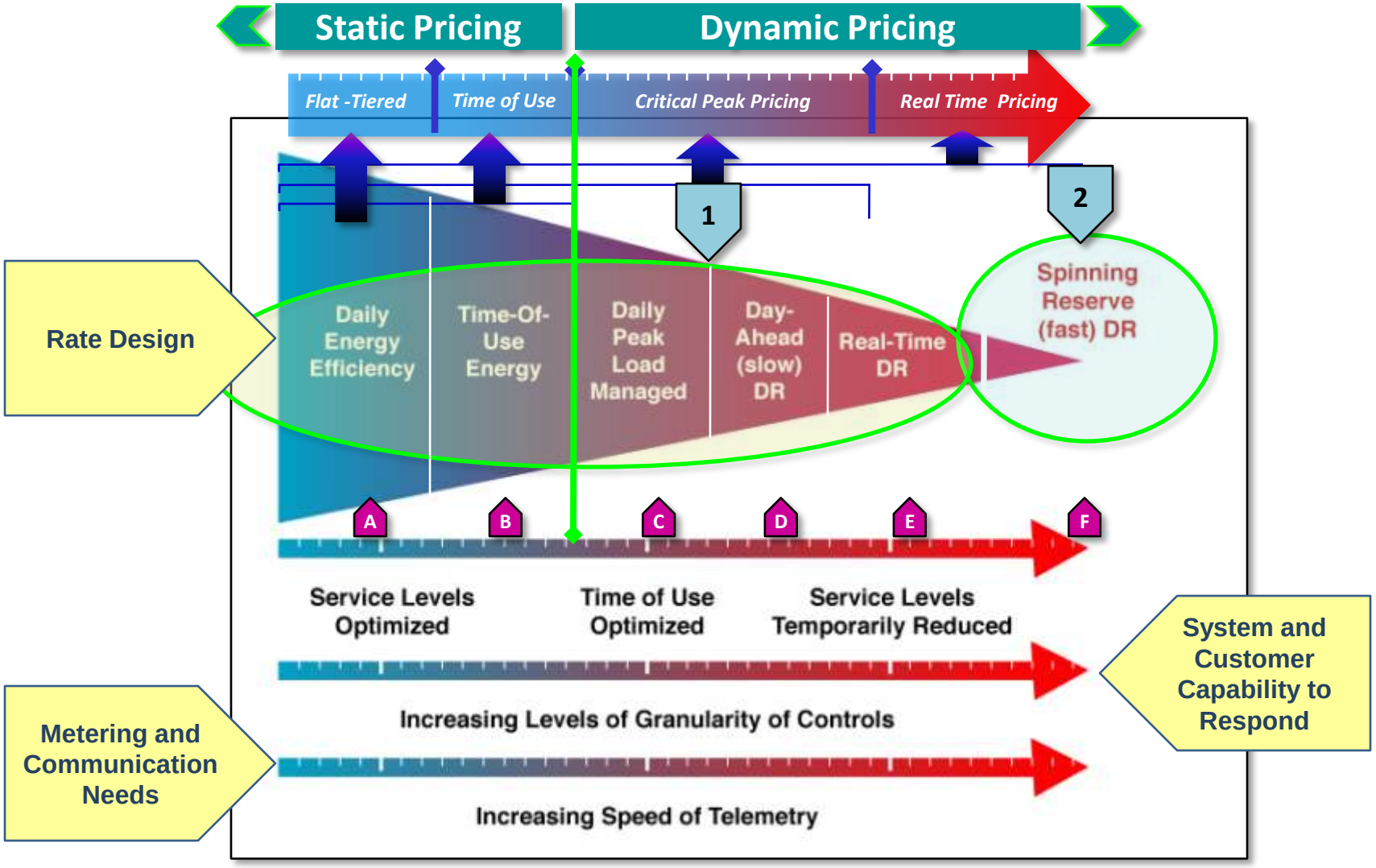
- Utility establishes technology, value, and protocols.

2. Rates and Pricing – Demand Response

Under some utility demand response programs, customers often can participate in only one option at a time.



2. Rates and Pricing – Demand Response



What are the Objectives ?

1. Reduce the Frequency of outages ?
2. Reduce Outage Duration ?
3. Contain the Magnitude / Scope of outages ?
4. Improve Customer Notification ?
5. Reduce Unserved kWh ?
6. Reduce Customer Outage Costs ?
7. Reduce the Outage Damage Function ?
8. Improve Reliability Indices ?

3. Reliability

Defining and Measuring Reliability

- There is no consistent definition, no universally applied industry standard for defining and reporting reliability [outages].
- "Major" and "Sustained" events don't capture power quality (sags and surges) or "momentary" outages.
- The value inherent in "outage management" is the reduction of the **customer outage cost**, which is a function of multiple variables including frequency, duration and customer type.

Clarify Objectives

- What is the reliability objective (frequency, duration, cost…)?
- Is there more than one solution ?
- Where in the system will reliability investments have the greatest value ?
- How will you determine if reliability investments have been effective ?
- Should you consider standardizing reporting criteria – IEEE 1366-2003 ?

4. Pilots or Transition

Pilot Programs – *considered "experiments" for testing or gauging short-term customer issues, rates, incentives, or technology options that may or may not lead to deployment.*

Transition Programs - *staged "implementations" or core deployments that begins with a "base" system and plan for systematic testing, acceptance and expansion with additional components over time.*

1. **What do you know ?**
2. **What are you trying to learn or test ?**
   a) **Customer acceptance**
   b) **Technology / Engineering Performance**
   c) **Market / system operation**

4. Pilots or Transition Plans

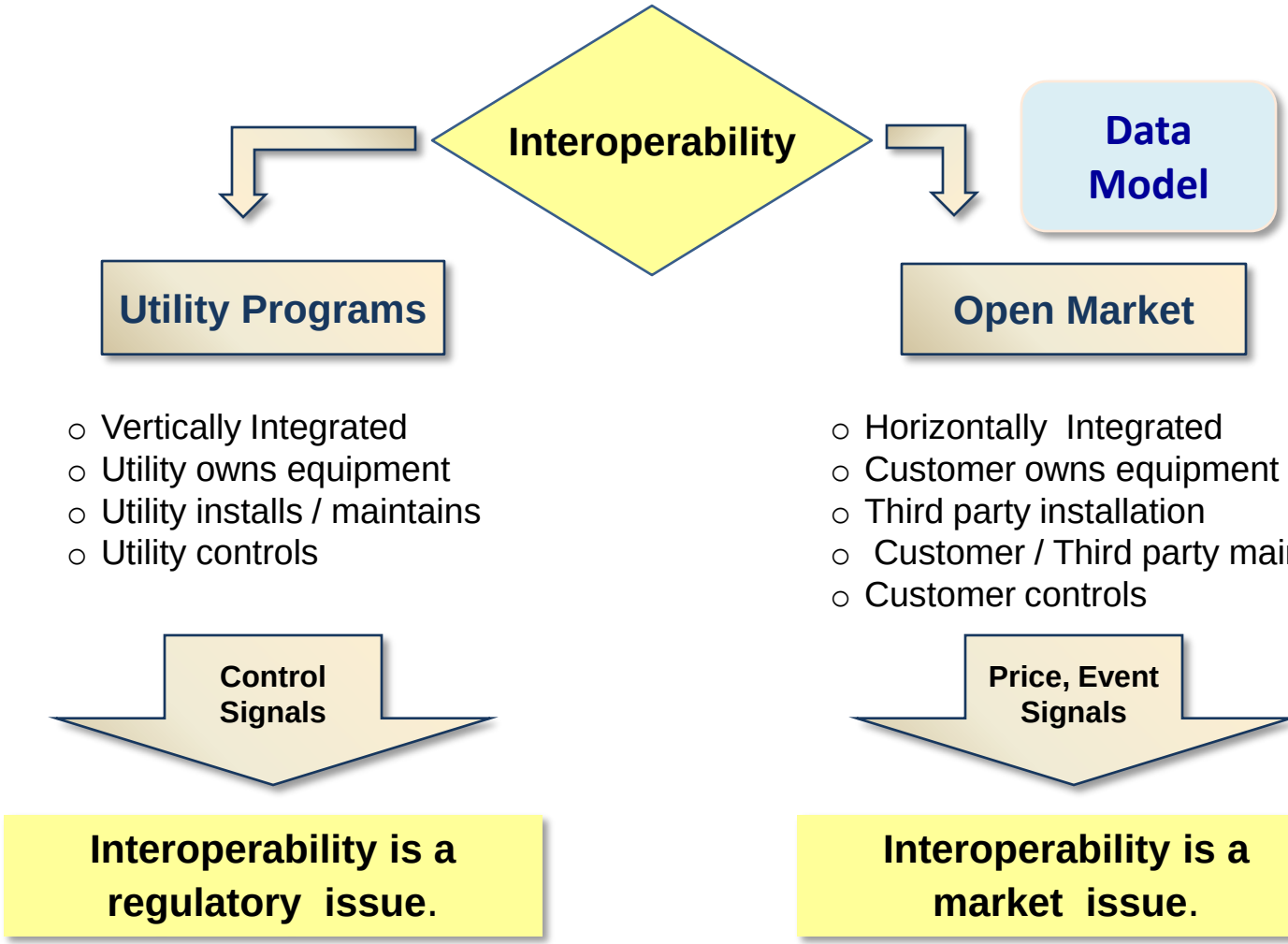
Attributes	Pilots	Transition Plans
Objective	Test and Evaluate	Systematic Implementation
Scope	1. Tech evaluation 2. Customer acceptance 3. Cost effectiveness	1. Tech implementation 2. Customer education 3. Operational effectiveness
Sampling	Yes – focus on representation	No – focus on operational integration
Customer Education	Restricted – avoid bias	Required – manage response
Duration	< 2 years	5 or more years
Back Office Integration	No – separate systems	Yes – integration objectives
System Operations	Separate systems	Integrated systems
Regulatory Approach	Voluntary participation	Default participation or opt-out
Equipment Ownership	Utility	Utility or customer
Customer Choice	Restricted	Open

5. Standards

Key Issues ?

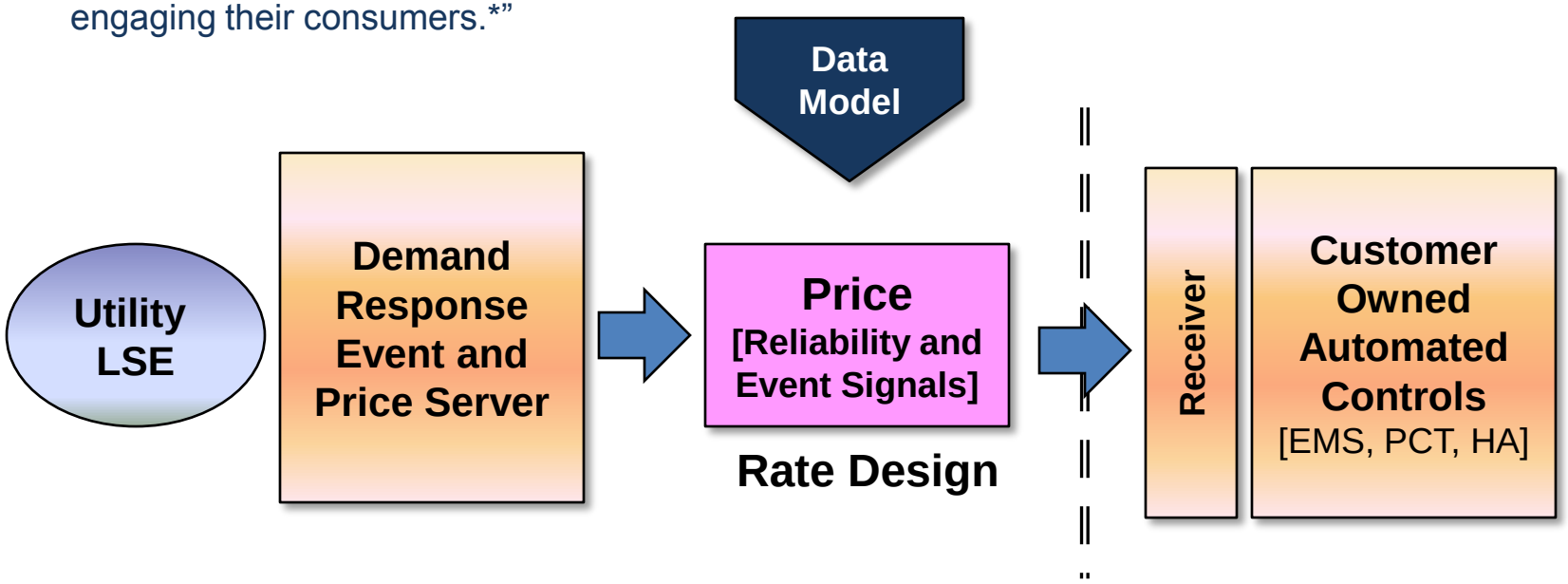
1. Interoperability
2. Obsolescence
3. Where are standards needed?
4. Key challenges?

5. Standards: Interoperability and Data Models



5. Standards: Interoperability and Data Models

"The **OpenADR** standard outlines specific communication models that use the Internet to send DR signals to end-use customer systems. The standard, initially developed for commercial and industrial applications, may be leveraged in residential settings to reduce cost, promote interoperability among DR technologies and allow utilities and energy providers to better manage pricing and critical load issues while actively engaging their consumers.*"



•"Tendril Achieves First Open ADR Compliant Platform", January 29, 2009, http://www.tendrilinc.com/2009/01/tendril-achieves-first-open-adr-compliant-platform-2/